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The Effect of Sod As a Soil Management Practice Upon the Growth and Yield of the Peach

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ROBERT G. HILL, JR.

INTRODUCTION

Cultivation with cover crops has generally been accepted as the best soil management practice for peach orchards. There is no question as to the desirability of the growth and yield responses of the peach to this method of soil management. It has limited, however, the number of otherwise desirable sites upon which peaches could be grown due to the inherent hazard of soil erosion associated with cultivation.

Most other orchard crops are maintained under a continuous sod cover. This method allows greater freedom in the selection of sites since the erosion problem is minimized. This type of soil management is generally regarded as unsatisfactory for peach production. The use of sod in peach orchards has been associated with reduced growth and yield.

The possibilities of wider site selection and reduced management problems offered by this method of culture have created a renewed interest in sod as a soil management practice for peaches. This publication is a report of a study undertaken at the Ohio Agricultural Experiment Station to evaluate sod as a soil management practice for the peach and to determine the nitrogen fertilization practices that should be followed with the peach in such sod orchards.

LITERATURE REVIEW

Waugh (17) states, that even though cover crops were occasionally used, the soil management practice generally followed in early peach orchards in the United States was that of cultivation. Not until 1900 (17) did the use of cover crops gain recognition among peach growers as a general orchard practice. Although the trend is toward less cultivation (12) the cultivation-cover crop system is now the most generally recommended soil management practice for this crop (4).

Many peach orchards, however, which are situated on high, sloping or rolling sites, in order to obtain the benefits of air drainage, suffer severely from soil erosion, an inherent hazard of the cultivation-cover crop system of soil management (3). The result (3, 10) is a general decline in the productivity of the orchard and a limiting of the use of otherwise desirable sites. An apparent solution to this soil management problem, the adoption of the sod system of culture for the peach, has been investigated by a number of workers (2, 5, 10, 11, 12, 13, 14, 16).

Different grasses and legumes have been established as permanent covers in peach orchards. The most widely planted cover has been bluegrass (10, 12, 16) but orchard grass (11) and other grasses (3) have been grown. Legume covers have included biennial sweet clover (13), ladino clover (11) and lespedeza (13). Grass-legume mixtures have also been considered (13, 14).

There is no marked advantage of legume over the non-legume sod covers in the peach orchards. No real difference was noted in a comparison (11) of tree responses to ladino clover or orchard grass sods. The more important factors in the selection of a cover appear to be (3) the depth of rooting of the cover as it is related to competition to the tree and the type of top growth as it relates to prevention of run-off and moisture penetration. Ellenwood's report (6) of the displacement of a ladino clover sod by bluegrass makes apparent a further important consideration, that of selecting a cover naturally suited to the area.

Some workers have considered the use of modified sod covers for peaches. Johnston (9) suggests the use of sod strips while others have considered the use of mechanical treatments which partially destroy the cover each year (8) and the addition of mulch under the trees (11). Since such modification destroys the true concept of sod culture, reference to such studies are omitted.

Judkins and Rollins (11) compared the performance during the first three growing seasons of two varieties of peaches uniformly fertilized and grown under cultivation and cover crops and in sod. Their results indicated that the use of a sod cover reduced tree growth by approximately 25 percent. This depressant effect of the sod system of culture upon young peach trees was also shown in other studies (5, 10, 12, 13). Judkins (11), however, found in another orchard that young trees in sod "made somewhat better growth" than those under cultivation where there was ample moisture.

Older trees have in general performed better under the sod system of culture than young trees. This has been related (3) to the fact that the better established tree can compete more successfully with established covers for the essentials of plant growth. Ellenwood (6) reporting on the performance of a well-fertilized, mature bearing tree in a sod grown orchard stated that peaches could be successfully grown in sod. Olney and Armstrong (13) reported that older peach trees grew better in sod than young trees. Another report (12) indicated that although sod depressed growth and yield during early bearing years, the same trees, when mature, "produced in a very satisfactory manner" under the sod system of soil management. New Jersey work (2) indicates that sod did not adversely effect growth of established trees and that there was no significant yield reduction during the ninth season. Van Haarlen's work (16) in which he compared the response of seedling peaches in their sixth to thirteenth year in sod and under cultivation, however, indicates a mean growth reduction resulting from the use of sod even with added nitrogen.

Judkins and Wander (12) did not associate any significant differences in date of bloom, ripening date, quality of fruit or winter injury of the wood or buds with the sod system of culture. Shauulis (14) in a rather detailed study noted an effect of sod as a soil management practice upon the development of individual peach fruits. This effect, a reduction in the rate of enlargement, was considered to be indirect, the effect of the sod on availiable soil moisture. Ford and Judkins (7) noted differences in the quality of the fruits produced by trees in sod with differential nitrogen and under cultivation. These differences were primarily associated with nitrogen fertilization practices affecting a delay in fruit maturity.

The response of the peach tree to the sod system of soil management has been associated with a number of factors other than age of a tree. The amount of available nitrate has been cited (2, 3, 6, 12, 14) as affecting these responses, as has available soil moisture (2, 10, 12, 14). The age of the tree when the sod was established has also been indicated (13) as has the depth of the soil (14) as important factors bearing on the response of the peach to the sod system of culture.

MATERIALS AND METHODS

The experimental orchard consisted of two adjacent sections. One was established in the spring of 1944 and the other in the spring of 1945.[1] All trees were of the variety Halehaven; planted 20 feet apart in both directions. The soil was a Wooster silt loam, deep and well drained. The site was relatively level, but afforded good air drainage.

[1]The orchard was established and maintained until 1950 under the supervision of W. P. Judkins.

For the comparison of different rates of nitrogen fertilization for sod grown trees, the orchard contained seven blocks of four plots each. There were four blocks in the 1944 section, two which had four trees per plot and two which had three trees per plot. There were three blocks with two trees per plot in the other section. The orchard also contained three blocks of ten trees each which were maintained under cultivation with cover crops. Two of these blocks were located in the 1944 section and one in the other. The blocks within the different sections were separated by buffer trees.

The areas maintained under sod were seeded to a meadow mixture containing alsike clover, red top, and bluegrass at the time of planting. The cover was dense bluegrass sod by the third year. Throughout the life of the orchard a heavy sod was maintained. These areas were mowed three to four times during each growing season. The clippings were not removed from the orchard, but were allowed to remain on the orchard floor. In late summer, an area about 18 inches wide was chopped clean about the base of each of these trees. The cultivated areas were sown to ordinary rye in mid-September each year. The rye was disked down in mid-May. Soybeans were sown each year as a summer cover crop.

The trees growing under cultivation with cover crops were fertilized annually with one-fourth pound of a 20 percent nitrogen carrier per year of tree age or the equivalent thereof. This rate of application was considered as normal and is referred to as 1 N.

The trees growing under sod were maintained under four different nitrogen fertilizer treatments. Treatments were assigned at random. All the trees within a given plot received the same treatment. The treatments were normal nitrogen (1 N) (the same as the trees maintained under cultivation) twice normal (2 N), four times normal (4 N), and a split application which consisted of a 2 N application applied at the regular time in mid-April and another 2 N application in early June (2 + 2 N). All fertilizer materials were spread uniformly beneath the drip of the branches. The study was concluded at the end of the 1954 season.

During the harvest season, records were maintained as to the time of ripening and the yield of fruit produced by the trees growing under the different treatments. The trees were spot picked when the fruits were firm ripe. During certain seasons, representative fruit samples were collected at each harvest date. These were used to determine fruit size, color, and quality as indicated by pH, total acid, and soluble solids content of extracted juice.

In mid-July and mid-August of the 1950-54 seasons leaf samples were collected. Twenty leaves were collected from each tree. The leaves were harvested from the mid-point of the current season's growth. The leaves from each plot were composited and washed. Twenty leaves selected at random from this sample were used immediately to determine the effect of treatment upon leaf color. These same leaves were used, in the case of the August sample, to determine leaf area. Leaf area was determined by means of an areaphotometer and leaf color by a reflectometer (10). The samples were then dried, the leaves ground, and the total nitrogen content ascertained by the Kjeldhal - Gunning method (1).

At the conclusion of each growing season the increase in trunk circumference and the amount of shoot elongation were ascertained. Trunk circumference measurements were made at the same location, approximately one foot above the surface of the soil. Shoot elongation was determined by measuring twenty representative terminal shoots selected at random about the periphery of each tree. Weight of prunings removed in the ordinary dormant pruning in the spring of 1954 was determined.

Rainfall and temperature records for each season were maintained. Wherever possible statistical methods were used in comparing the effects of the different treatments upon the various growth and yield characteristics. An analysis of variance was used for direct comparisons between the sod grown trees that received the different nitrogen treatments. Comparison between the cultivated trees and the sod grown ones was made by unpaired comparison or T test.

RESULTS

The results presented here will in general be limited to the responses of the trees to the different treatments during 1950-1954. The earlier responses have been previously reported (5, 7, 10).

FRUITING CHARACTERISTICS

Season of Bloom: There were no differences in the time of bloom noted that could be associated with the treatments under which the trees were maintained.

Season of Ripening: There were differences in the time of ripening of the fruits produced by trees maintained under the different treatments. Harvest season observations indicated that the fruits on the trees growing in sod and receiving 1 N nitrogen colored somewhat earlier than those on comparable cultivated trees. The fruits of the

2 N sod and the 1 N cultivated trees colored at nearly the same time while color development of the fruits of the more heavily fertilized trees was three to four days later.

When the yield data of all five seasons were adjusted to four picking dates on the basis of the percent of the total crop harvested on each picking, Table 1, the differences in harvest season became readily apparent. The 2 N sod trees, while producing a lower percentage of the crop during the first picking and a higher percentage during the third picking, were similar in harvest season to the 1 N cultivated trees. The 1 N sod trees matured their crops earlier than comparable cultivated trees. The 2 + 2 N and 4 N trees had a delayed harvest season. These differences were similar to those reported earlier (7). They are considered to be more closely related to the nitrogen treatment and its effect upon nitrogen level within the tree than to the soil management practice.

Table 1.—Percent of Total Crop Harvested on Four Adjusted Picking Dates from Halehaven Peach Trees Grown in Sod and Under Cultivation with Different Rates of Nitrogen Fertilization. Wooster, Ohio. 1950-1954.

Treatment	Adjusted Picking Dates 1	2	3	4
	Percent of Total Crop Harvested			
1 N Sod	34.1	50.1	13.6	2.2
2 N Sod	15.2	40.0	35.1	9.7
2 + 2 N Sod	12.8	24.6	39.0	23.6
4 N Sod	9.6	23.0	41.7	25.7
1 N Cult.	29.2	42.4	20.0	8.4

Yield: The yields for each season, except for 1950, were well within satisfactory ranges, Table 2. The 1950 yield was seriously reduced by early spring frosts that occurred just prior to bloom, when the temperature dropped well below freezing for five consecutive nights. The minimum temperature for this period was 17° F. There was no apparent relationship between the response to adverse temperature and treatment.

Of particular interest is the relationship of the yields produced by the trees grown according to conventional practice, cultivation plus cover crops and 1 N nitrogen and those of the sod grown trees. The yield of the sod grown trees which received the 2 N treatment was comparable, Table 2 and Figure 1, to that of the cultivated ones. The

Table 2.—Average Yield of Halehaven Peach Trees Grown in Sod and Under Cultivation with Different Rates of Nitrogen Fertilization. Wooster, Ohio. 1947-1954.

Treatment	1947	1948	1949	1950	1951	1952	1953	1954	Mean
	Average Yield per Tree (lbs.)								
1 N Sod	20.8	48.5*	56.5**	32.1	112.7**	136.2*	193.3*	178.2	97.3*
2 N Sod	15.9*	62.7	79.5**	47.0**	146.7	177.2	233.8*	240.4*	125.4
2 + 2 N Sod	21.7	63.8	112.3	53.1**	141.5	233.9**	254.2**	289.8**	146.3**
4 N Sod	20.7	57.3	112.9	34.9	126.4*	221.5**	220.2	246.4*	130.0*
LSD Sod trees									
5 percent	NS	9.0	22.1	7.4	18.6	26.7	27.1	66.1	9.4
1 percent	NS	12.0	29.5	9.8	24.7	35.3	36.1	88.1	12.5
1 N Cult.	23.2	59.0	112.3	30.4	144.1	162.3	214.1	180.5	118.6

*Different from Cultivated Trees at 5 Percent Level.
**Different from Cultivated Trees at 1 Percent Level.

average yield of these trees for the eight years revealed that there was no significant difference in the performance of the trees maintained under these treatments. There were, however, instances in which differences did exist.

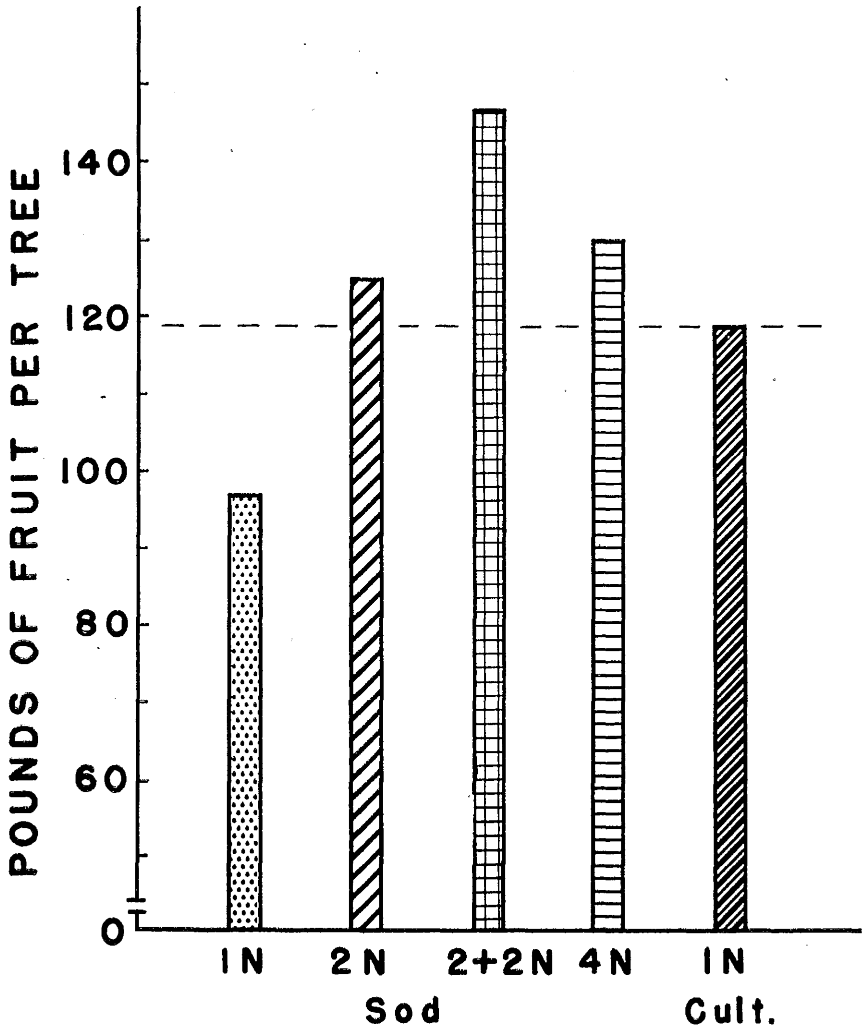

Fig. 1.—Mean yield of Halehaven peach trees grown in sod and under cultivation with different rates of nitrogen fertilization. Wooster, Ohio 1947-54.

The sod grown trees which received the 1 N treatment produced less fruit than the 1 N cultivated trees in seven of the eight seasons. In six of the seven seasons this difference proved to be significant. Over the eight year period the mean yield of the 1 N sod trees was 97.3 pounds while that of the 1 N cultivated trees was 118.6 pounds. Thus, an apparent yield reduction of 18.0 percent resulted from the use of sod when uniform nitrogen fertilization practices were followed.

The yield of the sod grown trees which received the 4 N treatment was not significantly different than that of the 1 N cultivated trees in five of the seasons, significantly better in two seasons, and significantly less during another. When the overall mean yields were compared it was found that the 4 N trees produced significantly more fruit than those under cultivation. The difference was 11.4 pounds.

The 2 + 2 N treated trees significantly out yielded the 1 N cultivated trees during four of the seasons. Over the eight years the mean yield of the 2 + 2 N was 27.7 pounds greater than that of the 1 N cultivated trees. This was a highly significant increase in yield. It is interesting to note the differences in yield between the trees that received the 4 N treatmnt as a single and as a split application.

The production of the trees maintained in sod was influenced by the rate of nitrogen application. The yield of the sod grown trees which received the 2 N treatment was significantly greater than that of 1 N sod trees in six of the eight seasons. The mean yields over the entire eight year period for the 1 N trees were 97.3 pounds while those of the 2 N trees were 125.4 pounds. This 28.9 percent increase in yield, which resulted from doubling the nitrogen application, was of highly significant and practical economic importance.

The 4 N treated trees produced significantly more fruit in five of the eight seasons than the 1 N treated sod trees, Table 2. When the mean yields of the two groups of trees were compared it was found that there was a highly significant difference in favor of the higher rate of nitrogen application. Although 4 N treated trees produced significantly more fruit than those that received the 2 N treatment during two seasons there was no important yield benefit noted as the result of the additional nitrogen. Over the entire period the average yield of the 4 N treated trees was only 4.6 pounds greater than that of the 2 N trees.

The differences in the yield responses of the trees that received the same amount of nitrogen, four times the normal rate, as a single application 4 N and as a split application 2 + 2 N are most interesting.

The 2 + 2 N trees significantly out yielded the 1 N sod trees in seven of the eight seasons. The average mean differences in yield for the entire study showed that the 2 + 2 N trees had produced 49 more pounds of fruit than comparable trees which received the 1 N treatment. The data showed that although the differences were of statistical significance in only two instances the 2 + 2 N trees, with the exception of the 1951 season, consistently out yielded the 2 N treated trees. Over the period of the study the difference in mean annual yield between the two treatments amounted to 20.9 pounds in favor of 2 + 2 N trees, a highly significant difference.

This difference in response between the split and single application is best shown when the yields of the trees that received these two treatments are compared. The 2 + 2 N treated trees consistently produced yields that were larger, except in 1949, than those trees that received the same amount of nitrogen in a single application. Even though the differences in yield were significant only in 1950 and 1953 when the overall mean yields were compared it was found that the yield of the 2 + 2 N treated trees was significantly larger than that of the 4 N treated ones. The yield difference amounted to 16.3 pounds.

Fruit Characteristics: As seasonal variation was not excessive the data relating to these characteristics are presented on the basis of the means for the five experimental seasons. The most outstanding

Table 3.—Some Characteristics of the Fresh Fruit Produced by Halehaven Peach Trees Grown in Sod and Under Cultivation with Different Rates of Nitrogen Fertilizations. Wooster, Ohio. 1951-1954.

Treatment	Wt./50 fruits (lbs.)	Fruit Color[1,2]	Soluble Solids (Percent)	Total Acid[2] (Percent Active)	Sugar: Acid
1 N Sod	19.0	77.1a	11.8	0.55a	21.5
2 N Sod	19.1	71.1a	12.0	0.51a,b	23.5
2 + 2 N Sod	19.4	56.1b	11.8	0.47b	25.1
4 N Sod	20.2	54.1b	11.6	0.48b	24.2
1 N Cult.	20.8	67.5a	11.7	0.49b	23.9
LSD					
5 percent	NS	----	NS	----	1.4
1 percent	NS	----	NS	----	1.9

[1]Percentage of fruits showing 75 percent or more overcolor.
[2]Values followed by different letters significantly different.

difference between the fruits produced by the trees maintaind under the different treatments, Table 3, was in the amount of red overcolor present on fruits at the same relative stage of maturity. A higher percentage of the fruits produced under the 1 N sod treatment had 75 percent or more of the surface covered by red color than did comparable fruit produced under cultivation. Fruits produced under the 2 + 2 N and 4 N treatments had significantly less red overcolor than those produced under the 1 N, 2 N, or 1 N cultivation treatments. The 2 N sod treatment trees produced fruits most nearly comparable in color to the 1 N cultivated trees. The lack of red coloration associated with the 2 + 2 N and 4 N treatments appeared to be of sufficient magnitude to affect the market value of the fruit.

These differences in fruit coloration were considered to be associated with the nitrogen level within the tree. Regression analysis computed for foliar nitrogen levels and fruit color produced highly significant "r" values which confirmed this assumption. The linear relation-

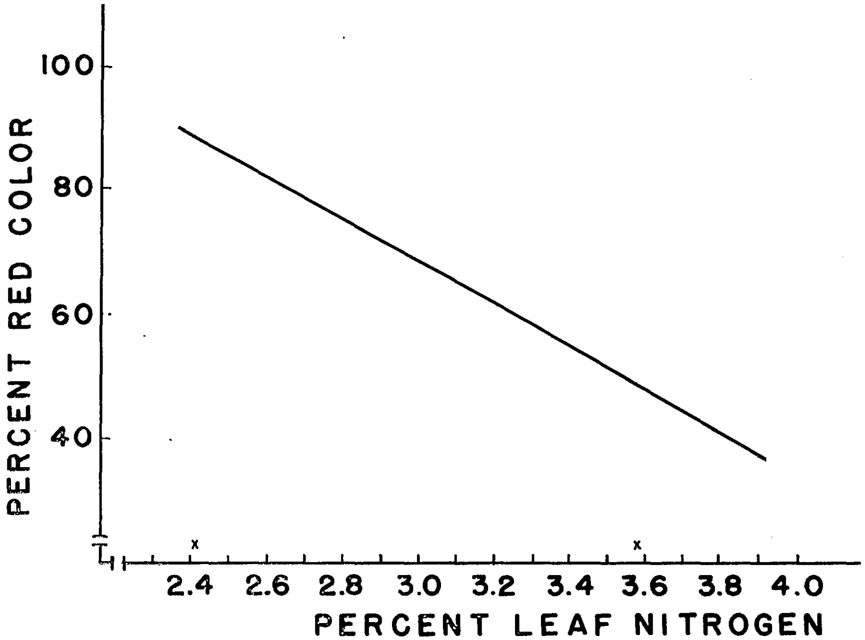

Fig. 2.—The relationship of the foliar nitrogen content to the amount of red overcolor on the fruits of the Halehaven Peach, Wooster, Ohio 1950-1954. Small x indicates limits of data used in establishing regression line.

ship between foliar nitrogen content in July and the amount of red overcolor is most interesting, Figure 2. These data indicate that the degree of fruit coloration was not influenced by soil management per se, but rather by the interaction of these practices and other factors upon the nitrogen level within the tree.

There were no important differences in the size or soluble solids content of fruits, Table 3, produced by the trees maintained under the different treatments. There were differences, however, in the titratable acid content associated with treatment, Table 3. There was a general decrease in the acid content of the fruits produced by the trees growing in sod as the rate of nitrogen application increased.

Fruits produced under the 1 N treatment were found to have a significantly higher acid content than those produced under the 2 + 2 N, 4 N, and the 1 N cultivated treatments. There was no difference in acid content between the fruits from the 2 N sod and the 1 N cultivated or 1 N sod treatment. These data as to acid content appear to be at variance with the results reported earlier (7). The differences are considered to be due primarily to the fact that in this study harvests were accomplished according to maturity status of individual fruits and trees whereas in the former studies representative fruits were harvested at a selected picking date from all trees. Data relating to the sugar acid ratio of the fruits generally reflected the same trend as those relating to acid content.

GROWTH CHARACTERISTICS

Shoot Growth: The shoot growth made by the trees maintained under cultivation and cover crops was quite satisfactory in 1950, 1951, and 1952, seasons in which more than 14 inches of rainfall occurred during the period from May to September. During these seasons the mean shoot growth was 30.2, 38.6, and 27.7 centimeters, respectively, Table 4. Ideal shoot growth for trees in comparable stages of development has been given as 10 to 15 inches (4) or about 25 to 38 centimeters. Shoot growth produced by these trees in 1953 and 1954 when rainfall during this period amounted to only 12.6 and 8.8 inches, respectively, was somewhat less than desired.

The trees maintained in sod and which received the 2 N treatment produced shoot growth that was most nearly comparable to that of the trees that were grown under cultivation and cover crops and the 1 N nitrogen treatment, Table 4 and Figure 3. In two of the five seasons considered there was no difference in the amount of growth produced by these two groups of trees while in the other three seasons the growth of the 2 N treated trees was slightly, but significantly, greater. Over the five year period the 2 N sod grown trees were found to have produced on the average 26.6 cms. of shoot growth, while the 1 N cultivated trees had produced an average of 25.9 cms. of growth.

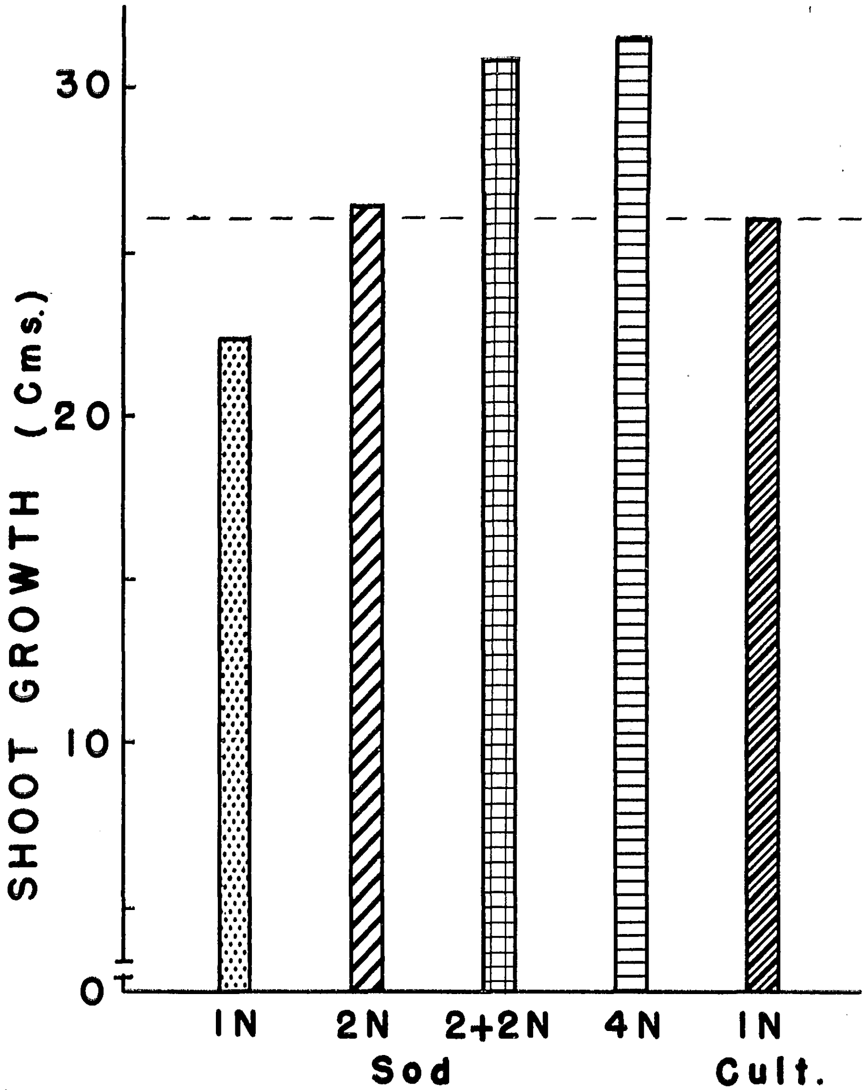

Fig. 3.—Average terminal shoot growth of bearing Halthaven peach trees grown in sod under differential nitrogen treatments and under cultivation plus cover crops with normal nitrogen. 1950-1954 Wooster, Ohio.

Table 4.—Average Terminal Shoot Growth of Bearing Halehaven Peach Trees Grown in Sod Under Differential Nitrogen Treatments and Under Cultivation Plus Cover Crops with the Normal Nitrogen Application. Wooster, Ohio. 1950-1954.

	Average Length of Shoots (cms.)					Mean
Treatment	1950	1951	1952	1953	1954	50-54
1 N Sod	29.4	32.1**	25.8**	13.8**	10.1**	22.2**
2 N Sod	35.5*	35.9	28.5*	18.4*	14.9	26.6*
2 + 2 N Sod	44.8**	38.5	33.1**	20.9**	17.2**	30.9**
4 N Sod	45.2**	40.1	33.8**	22.3**	16.4*	31.6**
LSD Sod trees						
5 percent	2.1	2.9	1.6	1.1	1.3	1.3
1 percent	2.8	3.9	2.1	1.6	1.7	1.7
1 N Cult.	30.2	38.6	27.7	17.6	15.4	25.9

*Different from Cultivated Trees at 5 percent level.
**Different from Cultivated Trees at 1 percent level.

The sod grown trees that had received the 1 N treatment were found to have produced significantly less growth than the similarly fertilized, cultivated trees in four of the five seasons. Over the five year period the 1 N sod grown trees produced an average growth, Table 4, of 22.2 cms. while the 1 N cultivated trees averaged 25.9 cms. of new shoot growth. Thus, an apparent 14.3 percent reduction in new growth resulted from the use of sod when uniform nitrogen fertilization practices were followed.

The shoot growth produced by the more heavily fertilized sod grown trees was greater than that produced by the 1 N cultivated ones. These increases in growth, except in 1951, were consistent and statistically significant. This growth was not considered to be excessive with the exception of the 1950 season. The differences in response to the single and split application noted in the case of yields were not, however, apparent. Over the five year period the 4 N treated trees made 12.2 percent and the 2 + 2 N treated trees 11.9 percent more shoot growth than the 1 N cultivated trees.

As has been indicated the amount of shoot growth produced by the sod grown trees was directly related to the amount of nitrogen which was applied. The 2 N treated trees produced significantly more growth than the 1 N treated ones, the 4 N treated ones significantly better growth than the 2 N treated trees.

The relationship of shoot growth to rainfall, indicated in regard to the cultivated trees, was even more clearly expressed by the data pertaining to the trees maintained in sod. The cultivated trees in 1954, when 8.8 inches of rainfall occurred in May-September, produced 50.3 percent of the growth made in 1950 when 19.9 inches of rain fell during the same period. When the same comparison was made with similarly fertilized sod grown trees it was found that only 34.4 percent as much growth was made during 1954 as 1950. These responses to limited rainfall of trees maintained under these soil management practices parallels that reported earlier (14).

Pruning Weight: The data relating to the weight of wood removed in ordinary dormant pruning in the spring of 1954, Table 5, reflected in general the responses to treatment already noted. There was no significant difference in the weight of prunings removed from the

Table 5.—Weight of Wood Removed in Ordinary Dormant Pruning of Bearing Halehaven Peach Trees Maintained in Sod and Under Cultivation with Differential Nitrogen Application. Wooster, Ohio. 1954.

Treatment	Weight of Prunings (lbs.)
1 N Sod	7.6**
2 N Sod	11.5
2 + 2 N Sod	15.3**
4 N Sod	12.0
LSD Sod trees	
5 percent	3.4
1 percent	4.5
1 N Cult.	12.1

*Different from Cultivated Trees at 5 percent level.
**Different from Cultivated Trees at 1 percent level.

1 N cultivated trees, the 2 N sod trees, or the 4 N sod trees. The amount of wood removed from the 1 N sod grown trees was significantly less than that removed from the trees which received any of the other treatments. Significantly, more prunings were removed from the 2 + 2 N sod grown trees than from any others, except the 4 N treated ones.

Increase in Trunk Circumference: The mean annual increases in trunk circumference, Table 6, did not appear to be as sensitive an index of the growth status of the trees growing under the different

Table 6.—Average Increase in Trunk Circumference and Final Size of Halehaven Peach Trees Grown in Sod Under Differential Nitrogen Treatments and Under Cultivation Plus Cover Crops with Normal Nitrogen Applications. Wooster, Ohio. 1950-1954.

Treatment	Average Trunk Circumference Increase (cms.) 1950	1951	1952	1953	1954	Final Size 1954
1 N Sod	4.7**	4.2**	4.3**	0.9	1.9	44.3*
2 N Sod	5.3	4.5**	4.5**	1.5**	2.1	47.4
2 + 2 N Sod	6.6**	5.2*	4.2**	1.6**	1.8	49.7**
4 N Sod	6.7**	5.2*	3.9**	1.6**	1.8	48.4*
LSD Sod trees						
5 percent	0.6	0.5	NS	0.3	NS	2.6
1 percent	0.8	0.7	NS	0.4	NS	3.4
1 N Cult.	5.3	5.6	3.3	1.1	2.0	46.5

*Different from Cultivated Trees at 5 percent level.
**Different from Cultivated Trees at 1 percent level.

treatments as did shoot elongation. These data did reflect, however, the relationship of growth to rainfall previously indicated. During seasons of limited rainfall, 1953 and 1954, increases in trunk circumference were less than those made in seasons of ample rainfall.

The trees which received the 2 N treatment, Table 6, produced increases in trunk circumference which were most nearly like those of the 1 N cultivated trees, Figure 4. There was no difference in this characteristic between the 2 N trees and the 1 N cultivated trees in 1950 and 1954. During two other seasons the 2 N treated trees made superior growth while in 1951 the 1 N cultivated trees made the larger increase in trunk circumference.

The growth of the 1 N sod grown trees was not as good as that of similarly fertilized, cultivated trees. Although the sod grown trees made significantly more growth in one season, during all other seasons their growth was not as good and during two the reduction in growth was statistically significant. In three of the five seasons the trees that received the 2 + 2 N and those that received the 4 N treatment produced significantly greater increases in trunk circumference than did the 1 N cultivated trees.

In two of the five seasons, the growth of the 2 N sod grown trees was significantly better than that of 1 N sod grown ones. During the other three seasons there was no difference in trunk growth between these two groups of trees. The trees that received the heavier rates of nitrogen fertilization produced significantly better growth than the 1 N sod trees in three of the five seasons and better than the 2 N sod trees in two of the five seasons. There was no significant difference

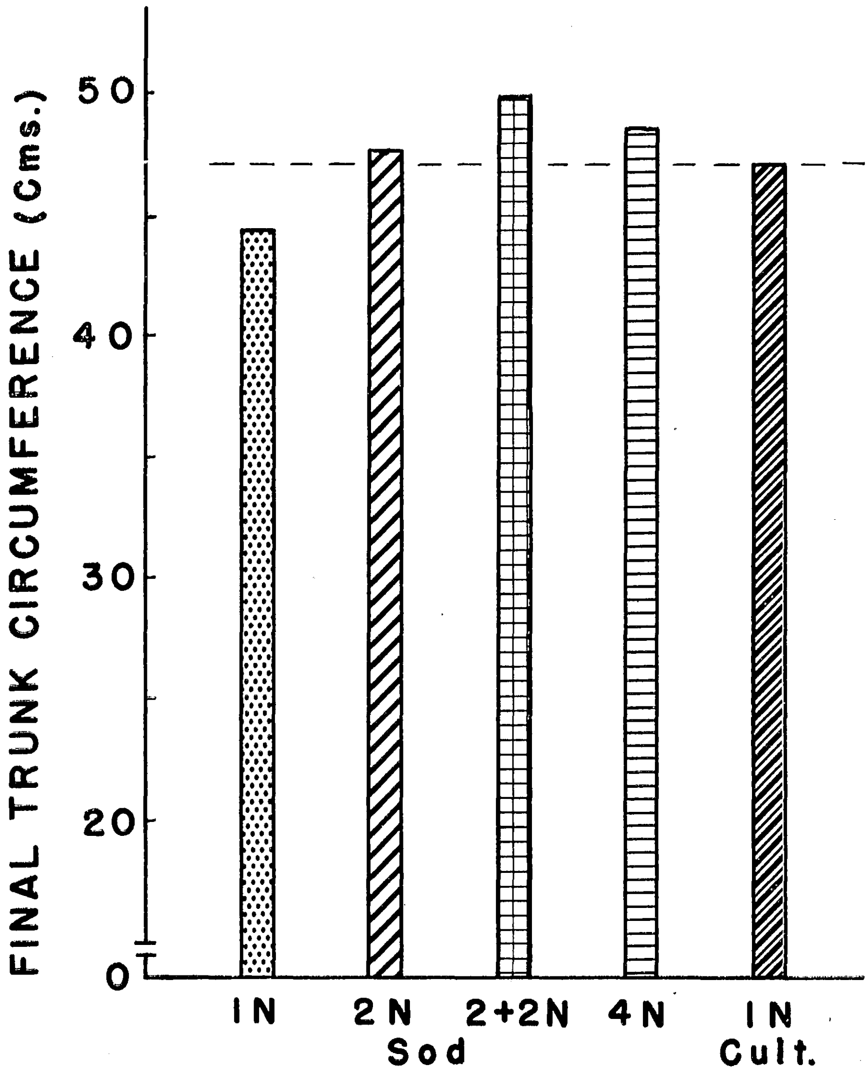

Fig. 4.—Average final trunk circumference of Halehaven peach trees grown in sod with differential nitrogen applications and under cultivation plus cover crops with normal nitrogen. Wooster, Ohio 1954.

in the growth response as indicated by trunk circumference between the 2 + 2 N and 4 N treated trees.

The most interesting comparison in the growth status of the trees, as indicated by trunk circumference data is that relating to the final size of the trees at the conclusion of the 1954 season, Table 6, Figure 4. These data indicate that the 1 N treated sod grown trees were significantly smaller than comparably treated trees grown under cultivation. Further, the trees that received the 2 + 2 N and 4 N treatments were significantly larger than the cultivated ones while the size of the 1 N cultivated trees and the 2 N sod grown trees was comparable. Although none of these differences were of any great magnitude, they are of interest.

LEAF CHARACTERISTICS

There were significant differences noted in the size, color, and nitrogen content of the leaves of the trees maintained under the different soil management and nitrogen fertilization treatments.

Leaf Nitrogen Content: As the rate of nitrogen application was increased there was a general increase in leaf nitrogen content, Table 7. These differences in nitrogen content were not, however, always significant. In general, the differences were larger during August than July.

The foliar nitrogen levels were compared to those suggested (15) as critical, in comparable tissue, of 2.80 and 2.88 percent for July and August sampling dates, respectively. This comparison suggested that, on five of the sampling dates in the case of the 1 N sod trees, on four dates in the case of the 1 N cultivated trees, and in one instance, August 1952, in the case of the 2 N sod trees, the foliar content of this plant nutrient element was well below the critical level. At no time during the course of the study were the characteristic symptoms of nitrogen deficiency exhibited by any of the trees under study. The nitrogen content of the 2 + 2 N and 4 N treated trees in 1950, a season of high rainfall and limited crop, was considered to be excessive.

The sod grown trees that received the 2 N treatment were found to have a higher nitrogen level, Table 7, than those that received the 1 N treatment on each sampling occasion. These differences were of sufficient magnitude to be of statistical significance in seven of the 10 comparisons. When the mean values for all sampling dates were determined, Table 8, it was found that 0.32 percent more nitrogen was in the leaves from the 2 N than 1 N treated trees.

The leaves of the trees which received the 2 + 2 N and 4 N treatments in 7 of the 10 comparisons contained significantly more

Table 7.—Comparison of Total Nitrogen Content of Leaves in July and August of Bearing Halehaven Peach Trees Maintained in Sod with Differential Nitrogen Treatments and Under Cultivation plus Cover Crops with Normal Nitrogen Applications. Wooster, Ohio. 1950-1954.

Treatment	1950	July—Nitrogen Content (% D. Wt.) 1951	1952	1953	1954	Mean 1950-54
1 N Sod	3.17	3.11**	2.46	2.74**	2.41**	2.78
2 N Sod	3.45	3.47	2.75**	3.00	2.91*	3.12
2 + 2 N Sod	4.20**	3.38**	3.00**	3.58**	3.34**	3.50
4 N Sod	4.21**	3.63**	3.03**	3.48**	3.31**	3.53
LSD Sod trees						
5 percent	0.79	0.53	0.42	0.10	0.16	
1 percent	1.08	0.73	0.57	0.14	0.22	
1 N Cult.	3.40	3.54	2.51	2.96	2.79	3.04

Treatment	1950	August—Nitrogen Content (% D. Wt.) 1951	1952	1953	1954	Mean 1950-54
1 N Sod	3.17	2.73**	2.36	2.82*	2.44*	2.70
2 N Sod	3.45*	3.01	2.65*	2.99**	2.84**	2.99
2 + 2 N Sod	4.20**	3.19*	3.02**	3.62**	3.21**	3.45
4 N Sod	4.21**	3.39**	2.91**	3.56**	3.14**	3.44
LSD Sod trees						
5 percent	0.23	0.15	0.18	0.15	0.17	
1 percent	0.31	0.20	0.24	0.20	0.23	
1 N Cult.	3.24	3.05	2.40	2.62	2.67	2.80

*Different from Cultivated Trees at 5 percent level.
**Different from Cultivated Trees at 1 percent level.

nitrogen than the 2 N sod trees and in 9 of the 10 comparisons significantly more than those of the 1 N treated ones. The averaging of all data, Table 8, showed the 2 + 2 N treated trees and the 4 N treated ones contained 0.74 and 0.75 percent more nitrogen than the comparable 1 N treated trees and 0.42 and 0.41 percent more, respectively, than the 2 N treated ones. There was basically no difference in foliar nitrogen content of the trees that were maintained under the 2 + 2 N and 4 N treatment.

The foliar nitrogen content of 1 N sod grown trees was significantly lower in five of the 10 tests than that of the 1 N cultivated ones. These results also showed that the 2 N sod trees had significantly more nitrogen in 6 of the 10 tests while the nitrogen level of the 2 + 2 N and 4 N treated trees was consistently and significantly higher than that of the 1 N cultivated trees.

When all the foliar analysis data were averaged, Table 8, it was found that the leaves of the 1 N sod trees contained 0.18 percent less nitrogen than the cultivated ones while the 2 N, 2 + 2 N, and 4 N trees contained 0.14, 0.56, and 0.57 percent more nitrogen than those maintained under cultivation and normal nitrogen. Although the foliage of the 2 N sod grown trees contained slightly more nitrogen than the 1 N cultivated ones these two groups of trees were considered to be most nearly comparable, Figure 5.

Table 8.—Mean Leaf Color, Area, and Nitrogen Content of Bearing Halehaven Peach Trees Grown in Sod with Different Nitrogen Fertilizer Treatments and Under Cultivation Plus Cover Crops and Normal Nitrogen Applications. Wooster, Ohio. 1950-1954.

Treatment	Relative[1] Leaf Color	Leaf Area Sq. Cms.	Leaf Nitrogen % D. Wt.
1 N Sod	50.8	29.0	2.74
2 N Sod	46.7	31.0	3.06
2 + 2 N Sod	43.7	32.7	3.48
4 N	43.3	32.4	3.49
1 N Cult.	49.8	32.5	2.92

[1]The higher the value the lighter the leaf color.

Leaf Color: The relative leaf color was found to be closely associated with the rate of nitrogen application. As the rate of application increased there was an increase in the intensity of the green color. This relationship has been reported earlier (10). The correlation coefficient between these two factors proved to be —0.765, a highly significant value. This relationship is expressed in Figure 6. In general, the relative leaf color values were the same on both sampling dates.

The leaves of the 2 N sod grown trees were found to be significantly darker in color than those of comparable 1 N treated trees in each of the nine comparisons, Table 9. The color of the leaves of the 2 + 2 N treated trees and those of the 4 N treated ones were found to be significantly darker than the 2 N sod grown trees in each comparison except that of July 1951. In every instance the 2 + 2 N and 4 N treated trees were found to have a more intense leaf color than that of the 1 N sod grown trees. There was no difference in leaf color values between the 4 N and 2 + 2 N trees. The mean values for the entire five year period for trees receiving these two treatments were 43.3 and 43.7, respectively, Table 8.

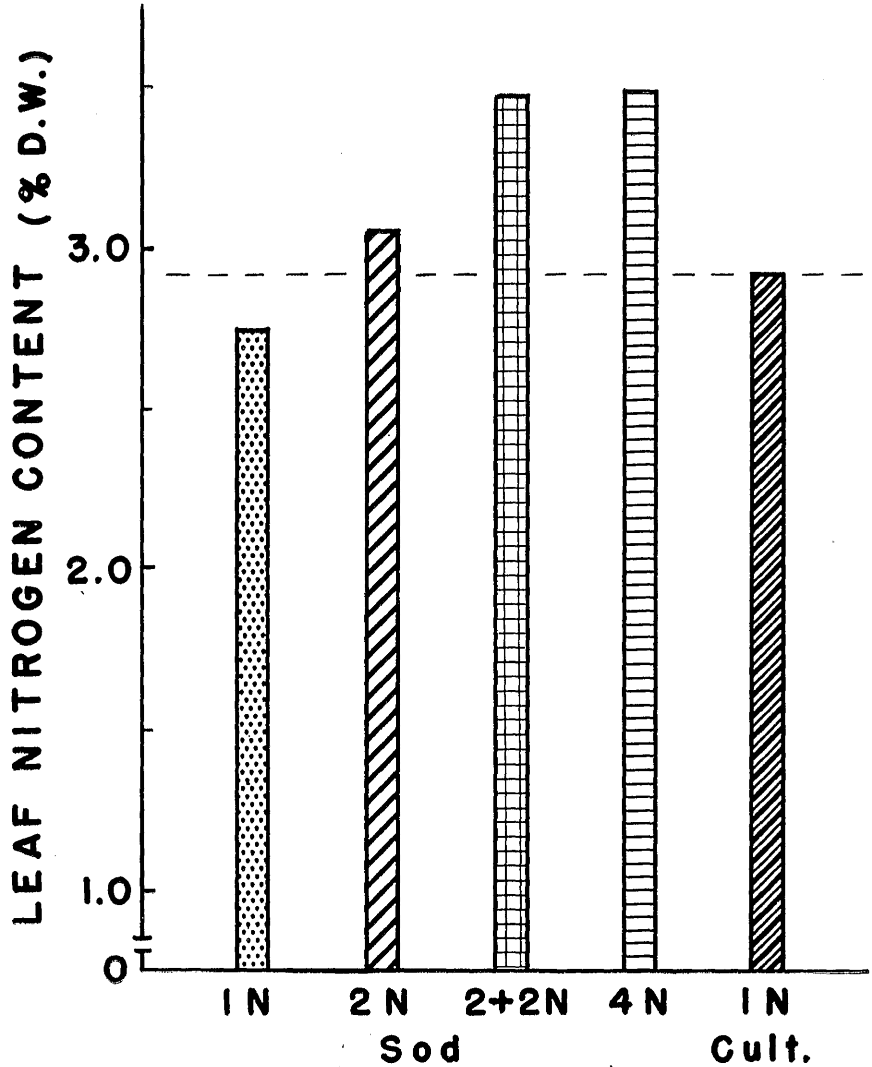

Fig. 5.—Mean foliar nitrogen content of bearing Halehaven peach trees grown in sod and under cultivation with different rates of nitrogen fertilization. Wooster, Ohio 1950-1954.

Table 9.—Comparison of the Relative Leaf Color[1] in July and August of Bearing Halehaven Peach Trees Maintained in Sod Under Differential Nitrogen Treatments and Under Cultivation Plus Cover Crops with Normal Nitrogen. Wooster, Ohio. 1950-1954.

Treatment	July—Relative Leaf Color[1] 1950	1951	1952	1953	1954	Mean 50-54
1 N Sod	47.3	48.0**	53.0	54.2**	54.8	51.5
2 N Sod	44.4	45.0	48.7**	49.1*	49.5**	47.3
2 + 2 N Sod	41.9**	44.9	46.0**	45.4**	44.8**	44.6
4 N Sod	41.1**	44.2*	44.6**	45.2**	45.0**	44.0
LSD Sod trees						
5 percent	2.5	1.6	1.9	2.1	2.2	
1 percent	3.4	2.2	2.6	2.9	3.1	
1 N Cult.	47.7	45.7	51.0	50.9	52.9	49.6

Treatment	August—Relative Leaf Color[1] 1950	1951	1952	1953	1954	Mean 50-54
1 N	——	49.5*	50.7	48.8**	51.4	50.1
2 N Sod	——	44.2**	45.9*	46.7**	47.2**	46.0
2 + 2 N Sod	——	41.1**	43.4**	43.4**	43.0**	42.7
4 N Sod	——	40.5**	43.8**	42.5**	43.6**	42.6
LSD Sod trees						
5 percent	——	1.7	1.7	1.0	2.9	
1 percent	——	2.4	2.4	1.4	4.0	
1 N Cult.	——	46.6	49.6	51.7	52.1	49.9

*Different from Cultivated Trees at 5 percent level.
**Different from Cultivated Trees at 1 percent level.
[1]The higher the value the lighter the leaf color.

It was found that the leaf color of the sod grown trees which received the 1 N treatment was significantly lighter in four of the nine comparisons but not significantly different in the other instances. There was no difference between the 1 N cultivated trees and the 2 N sod trees in two comparisons, but in the other seven comparisons the more highly fertilized trees had darker leaf color. The 2 + 2 N and 4 N trees' leaves were consistently darker in color than the ones from the cultivated trees. The relationship of treatment to leaf color for all sampling dates for all seasons, Figure 7, indicates that the close similarity between the 2 N sod trees and the 1 N cultivated trees was not exhibited by leaf color relationship.

Table 10.—Average Size of Leaf Produced by Bearing Halehaven Peach Trees Growing Under Sod with Differential Nitrogen Applications and Under Cultivation with Normal Nitrogen Application. Wooster, Ohio. 1950-1954.

Treatment	1950	Average Leaf Area (Sq. Cm.) 1951	1952	1953	1954	Mean 1950-54
1 N Sod	35.0**	34.0**	27.5	23.9**	24.7**	29.0
2 N Sod	38.2**	35.6*	28.2	26.4	26.6	31.0
2 + 2 N Sod	41.0	35.6*	29.0	29.2*	28.5	32.7
4 N Sod	40.6	36.7	28.5	28.5	27.6	32.4
LSD Sod trees						
5 percent	2.2	1.9	1.6	1.5	1.8	
1 percent	3.0	2.6	2.2	2.1	2.5	
1 N Cult.	40.8	38.3	28.2	27.6	27.6	32.5

*Different from Cultivated Trees at 5 percent level.
**Different from Cultivated Trees at 1 percent level.

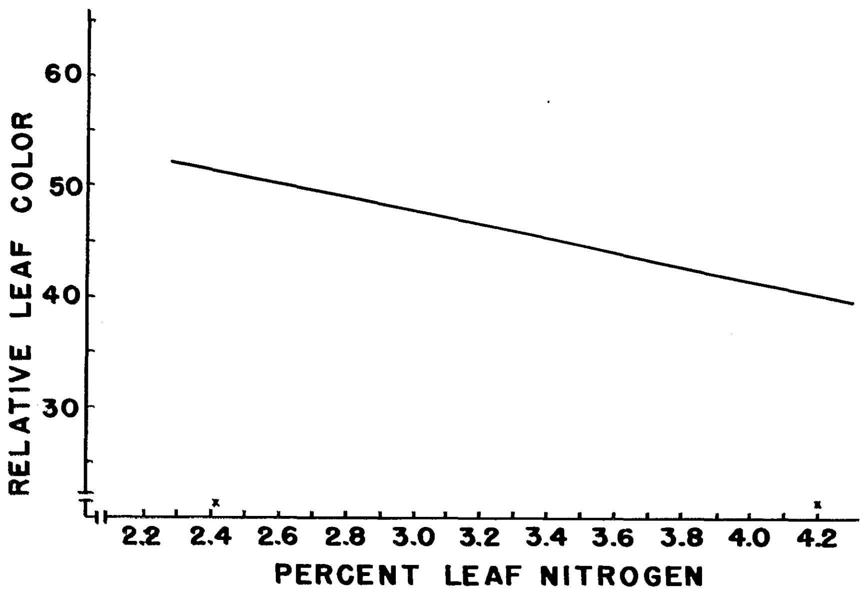

Fig. 6.—The relationship of the foliar nitrogen content to leaf color of the Halehaven peach, Wooster, Ohio 1950-1954. The lower the relative leaf color value the darker the leaf color. Small x indicates limits of data used in establishing regression line.

Leaf Area: There were no significant differences in size of leaves as a result of treatment during the 1952 season. There is no apparent reason for this situation and it is of special interest since the levels of

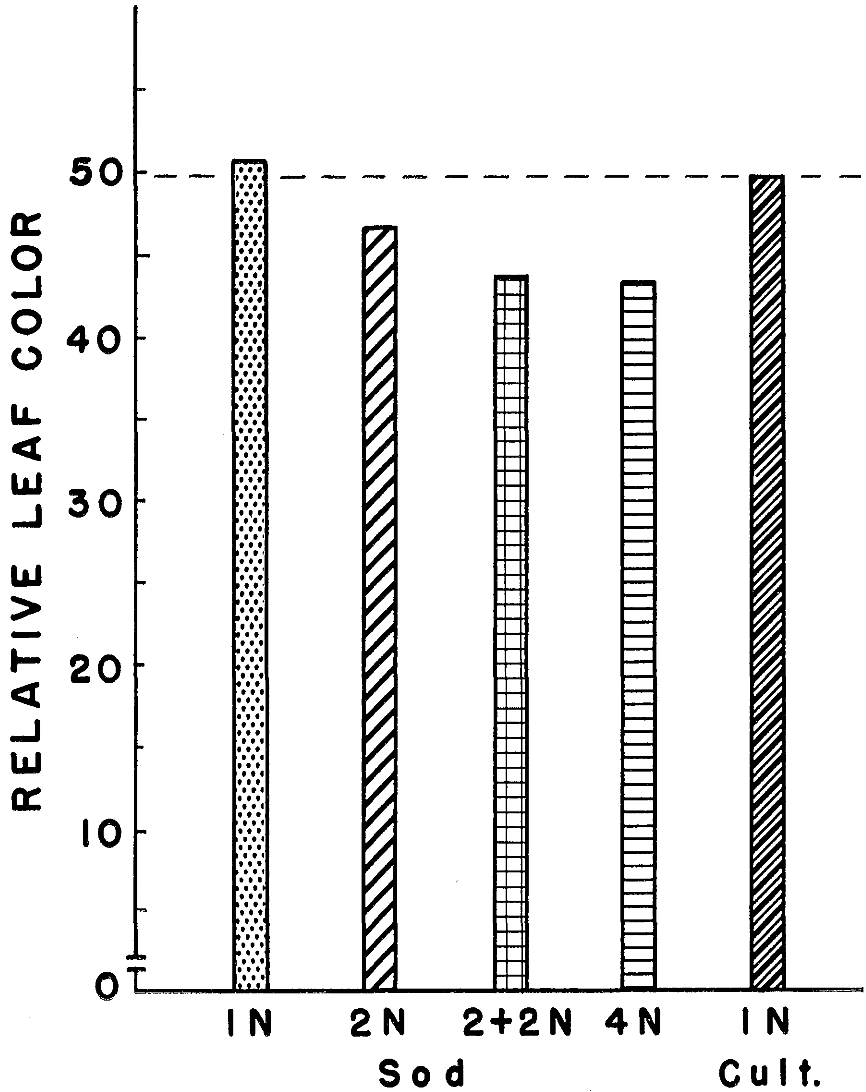

Fig. 7.—Relative color of leaves produced by bearing Halehaven peach trees grown in sod with differential nitrogen applications and under cultivation plus cover crops with normal nitrogen. Wooster, Ohio 1950-1954. The lower the value the darker the color.

nitrogen and leaf color difference of these leaves proved statistically different.

The sod grown 2 N trees were found, Table 10, to have produced

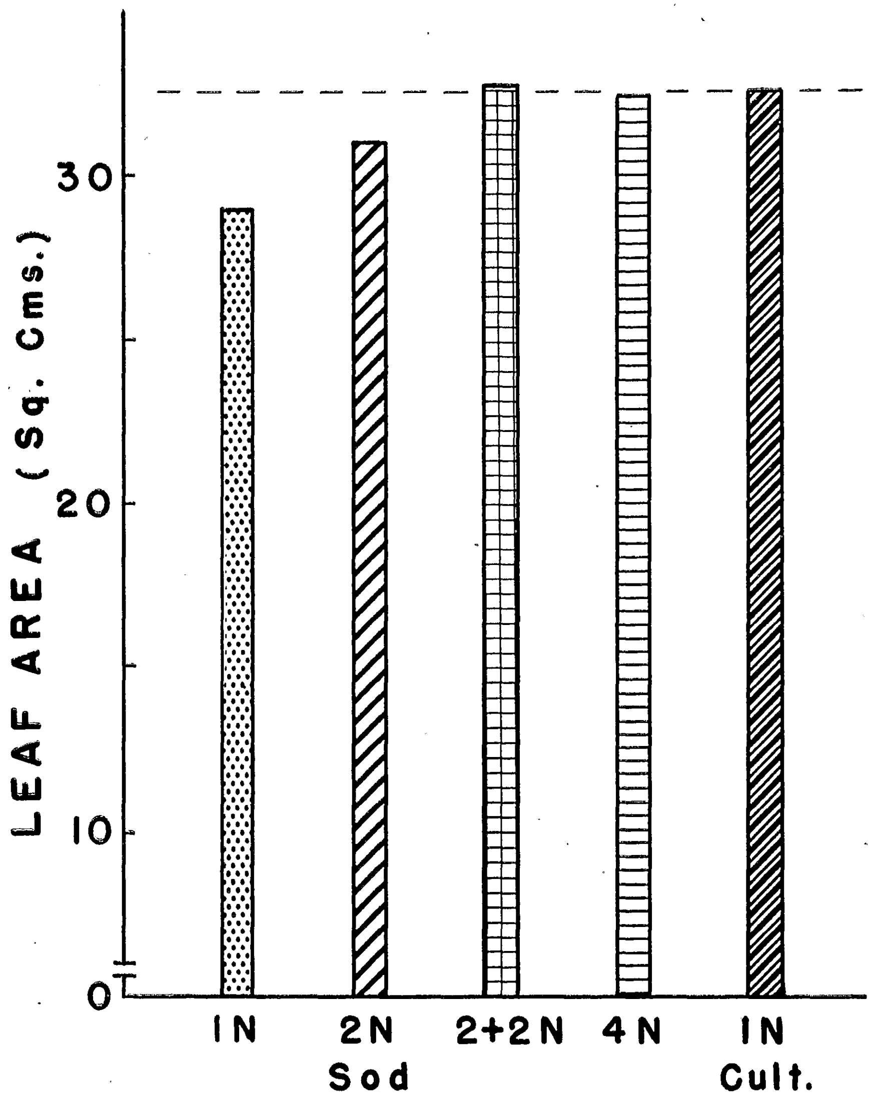

Fig. 8.—Average size of leaf produced by bearing Halehaven peach trees grown in sod with differential nitrogen application and under cultivation plus cover crops with normal nitrogen. Wooster, Ohio 1950-1954.

significantly larger leaves in three of the five seasons than the 1 N sod grown trees. The size of the leaves of the 4 N trees were significantly larger than the 2 N trees in two instances and significantly larger than the 1 N trees in four instances. The 2 + 2 N trees' leaves were larger than those of the 2 N trees' leaves in three instances and larger than those of the 1 N trees in three instances. There was no difference noted between the size of the leaves of the 2 + 2 N and 4 N treatments.

When the leaf area data for the five year test period were averaged it was found that the leaves of the 2 N treated trees were larger by 2.0 square cms. than those of the 1 N treated trees. Further, the area of the 4 N tree leaves were 1.4 and 3.4 square cms. larger than those of the 2 N and 1 N treated trees.

The sod grown 1 N treated trees in four of the five comparisons were noted to have significantly smaller leaves than those of the 1 N cultivated trees. Over the five year period, Table 10 and Figure 8, the average difference in size was 3.5 square cms. in favor of the cultivated group. The 2 N treated trees' leaves were significantly smaller in two comparisons. The five year average showed these leaves to be, on the average, smaller by 1.5 square cms. There was considered to be no real difference in size between leaves of cultivated trees and those of the 2 + 2 N and 4 N trees.

The mean difference in size between the leaves from these trees and those of the 1 N cultivated leaves was 0.1 and 0.2 square cms., respectively. A comparison between the leaf area and leaf nitrogen data suggests that factors other than leaf nitrogen have a major influence upon leaf size.

DISCUSSION

Although traditionally the use of permanent or semipermanent covers in peach orchards has been associated with reduced growth and yield, no evidence has been reported of a direct detrimental effect of any of the covers tested upon the performance of this crop. Apparently the benefits of cultivation in the peach orchard are related to the elimination or reduction of competition with the peach by other vegetation for available moisture and nutrients, particularly nitrogen. Hence, it is considered that the reported differences in the response of the peach tree to different soil management practices may not be due to the practices followed per se, but rather to the differences in available moisture and nutrients.

Therefore, the response of the peach to a soil management practice may be expected to be related to the depth and moisture holding capacity of the soil, the amount of rainfall or supplemental irrigation, and the fertility of the soil or the fertilizer program. The size of the tree as it relates to the extension of the root system and the size of the soil mass which the root system has explored may also have a major effect upon the response of the tree to the soil management practice, since the more extensive the root system the more successfully a tree may be expected to compete for essential moisture and nutrients.

Results obtained indicate that under the conditions of this study, peach trees growing in a permanent bluegrass sod can be expected to produce growth and yield comparable to that of trees maintained under cultivation and cover crops if they are maintained in comparable nitrogen status and have ample moisture. In this study the nitrogen status of the sod grown trees was maintained at approximately that of the trees under cultivation by doubling the rate of nitrogen application. It is not reasonable to expect, however, that this relationship would exist over the wide range of orchard sites which might be encountered. It would appear, therefore, that in sod grown orchards as in conventionally handled ones, that nitrogen applications must be made according to the characteristics of the tree rather than according to any set formula. Although the level of all essential plant nutrient elements must be maintained at a desirable level, emphasis is placed on the nitrogen status since under Ohio conditions it is the one most likely to be limiting.

The best, most precise gauge of the nitrogen status of the peach tree is no doubt that obtained by means of foliar analysis. Such a technique, when applied with proper sampling methods, gives an objective evaluation of the true nitrogen level of the tree. Due to the nature of such analytical procedures, however, such a technique can only be considered a tool of the research worker. Even before he can fully utilize it, however, more precise knowledge must be gained relative to the optimum nitrogen level for peach trees of different varieties during different seasons of the year.

Until a foliar analysis service is available to the grower it will be necessary for him to use less precise methods for evaluating the nitrogen status of his trees. Any of the indices of the growth and fruiting characteristics of the trees, used in this study, might be considered as grower gauges of the nitrogen status of the peach. The best of these gauges appears to be that of shoot enlongation. In evaluating this index, standards previously suggested (4) of 18 inches of growth for nonbearing trees and 10 to 15 inches of growth for bearing trees should be used. If, in general, the trees are making less growth than indicated by the standard, more nitrogen should be applied. If growth is in excess of the standard, the rate of nitrogen application should be reduced. Increase in trunk circumference, although influenced by the nitrogen status of the tree, is a less sensitive and less reliable indication of nitrogen requirement than shoot growth.

Leaf color, since it has been shown in this study to be highly correlated with leaf nitrogen content, might be expected to be a most suitable gauge of nitrogen status. In reality it cannot be considered of practical value because of the difficulty of establishing color standards.

Leaf color is purely a subjective method and differences in color can be influenced by factors other than the nitrogen status of the tree. If it were to be used, it would have to be in conjunction with a carefully prepared set of color standards and growers would have to be able to assign variations in color solely to differences in nitrogen content. Leaf color can best be used in conjunction with shoot growth. Leaf area, like trunk circumference, cannot be expected to serve as a satisfactory gauge due to the magnitude of the changes and the fact that other factors apparently play a major role in influencing leaf size.

Although there were differences in season of harvest and degree of red coloration associated with the nitrogen level these factors cannot be expected to serve as satisfactory indices of the nitrogen level within the tree. The indices may, however, be used to supplement that of shoot elongation for gauging the nitrogen status of the tree.

The generally recommended soil management practice for peach orchards (49) is cultivation with any of a number of different overwintering cover crops. The practice of establishing a summer cover, followed in this study, is not generally accepted. The performance of the trees maintained under these dual cover crop systems as indicated by both growth and yield was, however, highly satisfactory. Further, since the yield of the 2 + 2 N sod grown trees was over the years significantly better than the 1 N cultivated trees it cannot be considered that the 1 N cultivated trees were handicapped by a lack of moisture as a result of the use of this additional cover crop.

Under the conditions of this study, applying four times the normal amount of nitrogen as a single or split application to trees growing in sod resulted in some real differences in the growth and yield characteristics. When the performance of these trees was compared to that of the 1 N cultivated trees, it was found that they contained significantly more foliar nitrogen, had made more shoot growth, and produced fruits that were delayed in maturity and had markedly less red overcolor. Over the course of the study those that received the split application also produced a significantly greater yield.

If it is accepted that the growth and yield of the 1 N cultivated trees is the ideal or within the ideal range, then these data would suggest that under the conditions of this study such application rates were excessive. Further, it might be expected that the foliar nitrogen of trees so fertilized would be at the upper limits of the optimum range, or slightly above. This concept is borne out by the 1950 season's data which shows the foliar nitrogen content in excess of 4.2 percent and excessive shoot elongation. Although this concept is not borne out by the 1953 and 1954 season's data it is considered that this relationship was masked by the lack of rainfall.

On the other hand, the performance of the 1 N cultivated trees might be considered as being substandard and that the degree of red coloration was obtained at the expense of reduced growth and yield as a result of restricted nitrogen supply. If this concept is accepted, then these data must be interpreted as an indication that the performance of sod grown trees under such conditions can be further improved by the increased applications of nitrogen. Although the growth characteristics of the trees would void this interpretation of the data it is worthy of consideration.

Of particular interest is the difference in response to the four times normal nitrogen treatment when applied as a split instead of a single application. Basically this difference in response was apparent only in the productivity of the trees. This situation may be due to the availability of nitrogen during two different times in the physiological development of the tree.

The first instance is in early spring from the time of bloom until June drop. At this time it can be assumed that the amount of nitrogen available to the 4 N trees is considerably greater than that available to the 2 + 2 N trees since the latter group had only half as much nitrogen applied. Under these conditions the 4 N trees would be in a more vigorous state and a reduced fruit set might be expected.

The other stage of development at which nitrogen availability is considered to be a factor in this response is during flower bud differentiation. At this stage it can be assumed that there is more nitrogen available to the 2 + 2 N trees than to the 4 N trees, since the later applications of one half of the total quantity would limit the loss via fixation in the tree and leaching. Thus, it might be expected that greater numbers of flower buds might be formed as a result of more available nitrogen. This appears to be a plausible explanation of the situation encountered.

Calculations using the fruit size and yield data supported the fact that larger numbers of peaches were produced on the 2 + 2 N treated trees than on the 4 N treated ones. The trees that received the split application were calculated to have produced an average of 585 fruits per tree, while those receiving the single application produced 505 fruits per tree. Unfortunately, collection of other data which would give credence to this explanation was not within the scope of this study.

Classically, fruit sites in nonirrigated temperate regions have been considered to require approximately 40 inches of annual rainfall of which approximately one inch per week should fall during the growing season, May-September, or about 20 inches. This classical concept has been commonly used as a gauge of suitability of the rainfall characteristics of any given fruit site. Data obtained in this study, with well-established peach trees growing in a deep, well-drained soil indicate that this may not be a satisfactory criterion for evaluating the rainfall characteristics for such fruit sites.

During 1953 and 1954, the growing season rainfall was 12.6 and 8.8 inches, respectively. This amount of precipitation when compared to the 10 year average for this site of 18.4 inches or to the classical concept was markedly deficient. Yet during these two seasons, although shoot growth was curtailed, the mean yields were the largest of any of the seasons considered. Further, although the trees received only 69.5 percent as much growing season rainfall in 1954 as they did in 1953 they produced comparable mean yields and mean shoot growth which was 77.4 percent of the earlier season.

Considering these facts and the depth and soil moisture holding capacity of the soil, it appears that perhaps a better criterion of the rainfall characteristic on such sites would be the total amount of precipitation that falls on the site from the end of one growing season to the end of the next. This means the rainfall that occurs during the growing season plus the precipitation that is accumulated during the previous fall and winter months. The application of this concept to the 1953 and 1954 growing seasons showed that the total amount of precipitation that affected the 1953 crop was 26.9 inches and that affecting the 1954 crop was 25.4 inches. Although undoubtedly some of this moisture was lost to the trees these values appear to indicate much more realistically the productive potential of the site than did the growing season rainfall. On sites whose soil has less depth and moisture holding capacity, however, rainfall occurring during the growing season may still be the best guide to this characteristic. Where supplemental irrigation is available to offset seasonal moisture deficits, except for the economic factors, rainfall consideration in site evaluation may be minimized.

There is ample evidence (12, 13) that, in general, young trees are more apt to be adversely effected by the competitive nature of sod than older, better established trees. Thus, particularly on sites which are apt to be limited in soil moisture, special care must be exercised as to the time that the sod cover is established. It would appear that the establishment of sod as the soil management practice should be delayed until the trees are established. Perhaps best results would be obtained, if the terrain allowed, by maintaining the entire orchard under cultivation during the first growing season and seeding the permanent cover in fall. If the terrain is such as to make such a procedure hazardous, the row area itself should be kept cultivated the first season while the sod cover is seeded into the area between the row. Attempting to set young trees in a permanent, well-established sod cover would appear most difficult.

Although the problems of assuring ample quantities of moisture and nutrients are intensified by the use of a permanent sod cover, sod, as a soil management practice for peach orchards, appears to be well worthy of grower consideration, particularly on sites where soil erosion may become a problem if conventional practices are followed. The results of this study indicate that where ample rainfall can be anticipated or supplemental irrigation can be applied along with proper fertilization practices that growth and yields may be expected which are comparable to those obtained in cultivated orchards. Further, there is no reason why such a soil management practice could not, in fact, be substituted for more conventional practices even on sites where soil erosion is not a factor if there are ample moisture and nutrients available to support growth of the tree and the sod cover.

The sod system of soil management has the most potential value to the peach industry in that it will allow greater freedom in site selection. Through its use, sites which were considered unsatisfactory solely because of problems of soil management can be effectively used. Even though orchards established under such conditions might be expected to experience occasional seasons of moisture deficit and hence reduced production, they may be expected to produce satisfactorily over a period of years.

SUMMARY AND CONCLUSIONS

A study was conducted at Wooster, Ohio, to determine the suitability of sod as a soil management practice for the peach. Comparison was made between the growth and yield responses of bearing Halehaven peach trees maintained in sod under different nitrogen treatments and under cultivations plus cover crops and normal (0.05 pounds of nitrogen per year of tree age) nitrogen. Data obtained in this study indicated:

1. The growth and yield responses of the trees maintained in sod which received twice the normal rate of nitrogen fertilization were comparable to those of the trees maintained under cultivation plus cover crops and normal nitrogen fertilization.

2. Comparisons between trees growing in sod and under cultivation which received the normal rate of nitrogen showed the sod grown trees made significantly less growth and yield. The fruit from the sod grown trees was characteristically more highly colored and earlier ripening.

3. There was no important or significant difference in the yield of the sod grown trees that received four times as much nitrogen in a single application as comparable cultivated trees. Sod grown trees which received the same heavy rate of nitrogen in a split application produced significantly more fruit than the cultivated trees. The heavier rates of nitrogen were associated with delayed maturity and reduced red overcolor.

4. Sod grown trees were more sensitive to periods of moisture stress, as indicated by the amount of shoot elongation, than trees maintained under cultivation.

5. Peaches may be expected to preform as satisfactorily in sod as under cultivation, so long as ample quantities of moisture and nutrients are available.

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